Transport across plasma membrane

Lecturer: Mrs Rohana

Biology Practical Report

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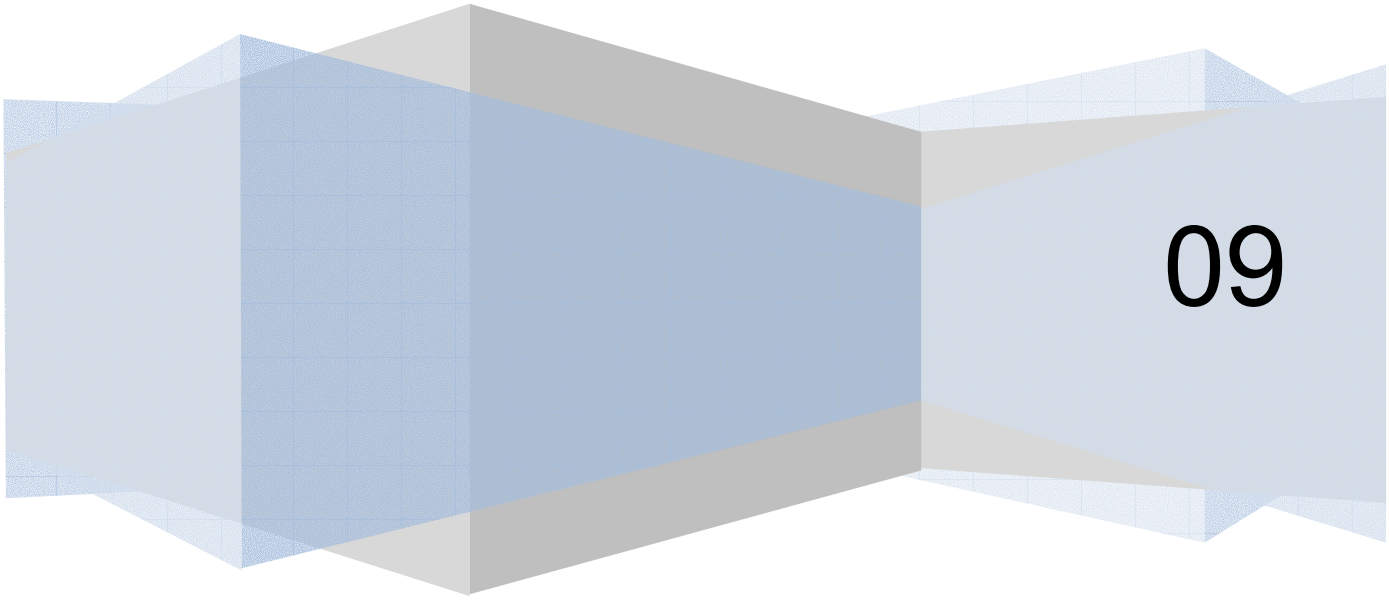

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Title: Transport across membrane

Aim: To investigate the osmosis in apple and potato tissue when immersed in different concentrations of glucose solution.

Research question: What is the effect in length of the potato and apple strips when submerged in glucose solution with difference concentration that is 0.2M, 0.3M, 0.4M, 0.5M and 1.0M for 120 minutes?

Hypothesis: As the concentration of the glucose solution gets higher, the differences in length of the strips get bigger.

Variables:

Independent variable: Concentrations of glucose solution.

Dependent variable: Different in length of the strips of apple and potato.

Constant variable:

1. Initial length of the apple and the potato strips which is 4.5 cm and their diameter 0.4 cm. The diameters are fixed by using exactly the same size cork borer while the length of the strips which is 4.5 cm measured using a 15 cm ruler.
2. Time taken for the apple and potato strips to be immersed in their respective glucose solution that is fixed to 120 minutes. The initial time of the strips started to immerse in the glucose solution is taken and they are taken out from the glucose solution after 120 minutes with uncertainties one minute.
3. Volume of the glucose solution which is fixed to 20 ml. The volumes are kept constant at 20 cm^3 by measuring them using a measuring cylinder at each trial.

Materials: 50cm^3 of 1.0 mol dm^{-3} glucose solution, distilled water, potato tuber, apple and filter paper.

Apparatus: Boiling tube, cork borer, 15 cm ruler, razor blade, tile, 25.0 cm^3 measuring cylinder, forceps, covered Petri dish, stop-watch, marking pen, labelling paper and a 50 ml beaker, 10 cm^3 pipette.

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Data collection and processing:

Quantitative data :

Table 1.1: Table shows the recorded data for the initial length of the apple strips, cm and the final length of the potato strips, cm.

Boiling tube	Concentration of the glucose solution, $moldm^{-3}$	Initial length of the apple strips, cm (±0.05cm)			Average	Standard deviation	Final length of the apple strips, cm (±0.05cm)			Average	Standard deviation
		1	2	3			1	2	3		
A	0.2	4.50	4.50	4.50	4.50	0.00	4.90	4.90	4.90	4.90	0.00
B	0.3	4.50	4.50	4.50	4.50	0.00	4.90	4.80	4.80	4.83	0.06
C	0.4	4.50	4.50	4.50	4.50	0.00	4.70	4.90	4.80	4.80	0.10
D	0.5	4.50	4.50	4.50	4.50	0.00	4.60	5.00	4.60	4.73	0.23
E	1.0	4.50	4.50	4.50	4.50	0.00	4.20	4.30	4.40	4.30	0.10

Table 1.2: Table shows the recorded data for the initial length of the potato strips, cm and the final length of the potato strips, cm.

Boiling tube	Concentration of the glucose solution, $moldm^{-3}$	Initial length of the potato strips, cm (±0.05cm)			Average	Standard deviation	Final length of the potato strips, cm (±0.05cm)			Average	Standard deviation
		1	2	3			1	2	3		
A	0.2	4.50	4.50	4.50	4.50	0.00	4.70	4.60	4.70	4.70	0.10
B	0.3	4.50	4.50	4.50	4.50	0.00	4.50	4.50	4.50	4.50	0.00
C	0.4	4.50	4.50	4.50	4.50	0.00	4.60	4.30	4.30	4.40	0.17
D	0.5	4.50	4.50	4.50	4.50	0.00	4.40	4.30	4.20	4.30	0.10
E	1.0	4.50	4.50	4.50	4.50	0.00	4.30	4.10	4.10	4.20	0.12

By using the data in the table 1.1 and 1.2 the difference in length of the apple and potato strips are calculated by using the formula below.

Difference of length of each apple/potato strips, cm:

Initial length of each apple/potato strips, cm – Final length of each apple/potato strips, cm

For example:

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The following shows the calculation for the potato strips immersed in 0.2 M of glucose solution.

Difference in length for the first potato strip, cm:

= (4.50 ± 0.05 cm)-(4.50 ± 0.05 cm)

= (0.00 ± 0.1 cm)

Difference in length for the second potato strip, cm:

= (4.50 ± 0.05cm)-(4.50 ± 0.05cm)

= (0.00 ± 0.1cm)

Difference in length for the third potato strip:

= (4.50 ± 0.05cm)-(4.50 ± 0.05cm)

= (0.00 ± 0.1cm)

- The other values of difference in length for the apple and potato strips are recorded in table 2.1 and 2.2 respectively.

Table 2.1: Table shows the difference in length of the potato strips, cm immersed in different concentration of the glucose solution, M.

Boiling tube	Concentration of the glucose solution, M	Difference in length of the potato strips, cm (±0.1)		
		1	2	3
A	0.2	+0.4	+0.4	+0.4
B	0.3	+0.4	+0.3	+0.3
C	0.4	+0.2	+0.4	+0.3
D	0.5	+0.1	+0.5	+0.1
E	1.0	-0.3	-0.2	-0.1

Table 2.2: Table shows the difference in length of the apple strips, cm immersed in different concentration of the glucose solution, M.

Boiling tube	Concentration of the glucose solution, M	Difference in length of the apple strips, cm (±0.1)		
		1	2	3
A	0.2	+0.2	+0.1	+0.2
B	0.3	-0.0	-0.0	-0.0
C	0.4	+0.1	-0.2	-0.2
D	0.5	-0.1	-0.2	-0.3
E	1.0	-0.2	-0.4	-0.4

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By using the same data in table 2.1 and 2.2, the average difference in length of the apple/potato strips are calculated using the formula below:

Average of difference in length of the apple/potato strips:

$$\frac{\text{Sum of all the apple/potato strips that is immersed in the same concentration of glucose}}{3}$$

=Average difference ± Standard deviation

Standard Deviation, σ

$$\sigma = \frac{\sqrt{\sum (x - \bar{x})^2}}{n - 1}$$

σ=standard deviation

X= average

Σ= sum

X= lengths of strips

N= number of strips

For examp

The following shows the calculation of the average difference in length of potato strips for 0.2 M of glucose solution.

$$= \frac{(0.20\ cm + 0.10\ cm + 0.20\ cm)}{3}$$

$$= 0.1667 \pm 0.0470$$

- For other values of average difference of potato strips, cm for each glucose concentration, mol/dm^{-3} please refers to the table 3.1.

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Table 3.1: Table shows the recorded data for the average difference of the potato strips, cm for each glucose concentration mol/dm^3.

Molarity, M	Average difference of potato strips, cm
0.2000	0.1667 ± **0.0470**
0.3000	0.0000 ± **0.0000**
0.4000	0.1667 ± **0.0470**
0.5000	0.2000 ± **0.0816**
1.0000	0.3333 ± **0.0944**

- *Note that all the standard deviation value is in bold state.*

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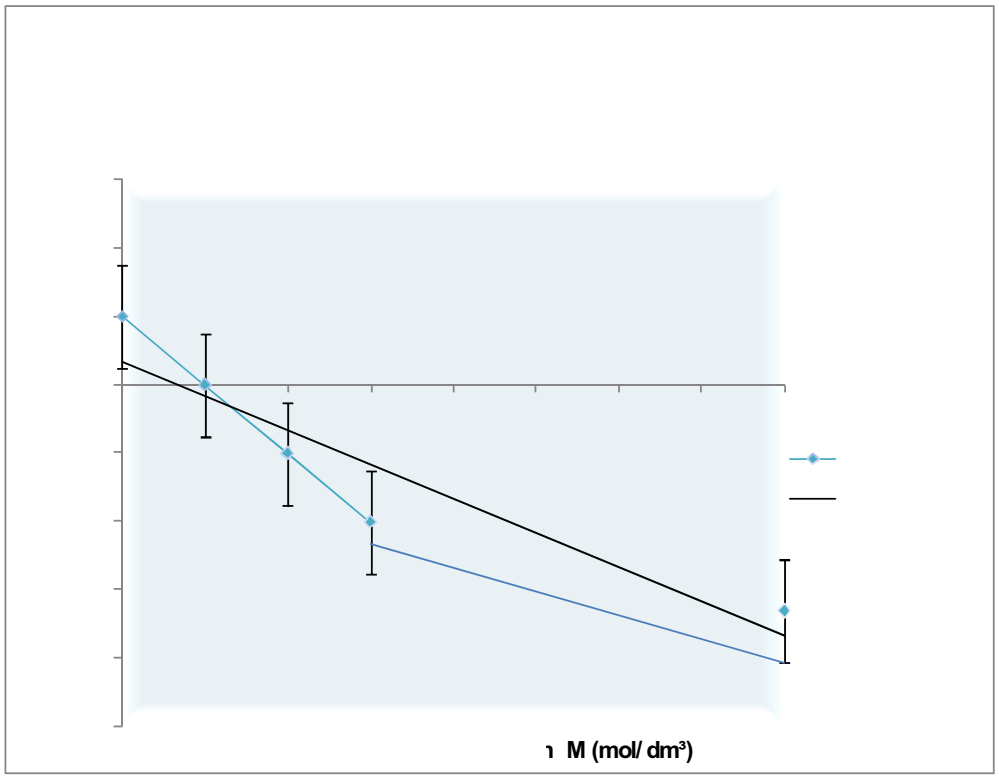

Graph 1.1: Shows the difference in length of potato strips against the concentration of sucrose solution.

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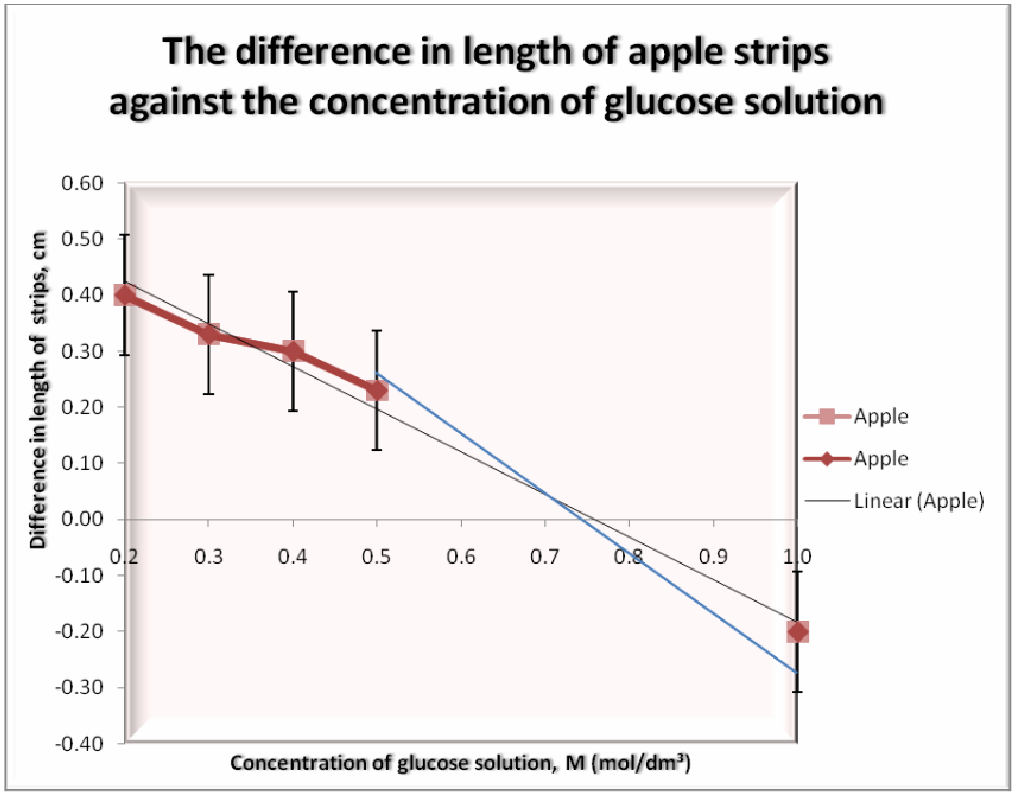

Graph 1.2: Shows the difference in length of apple strips against the concentration of sucrose solution.

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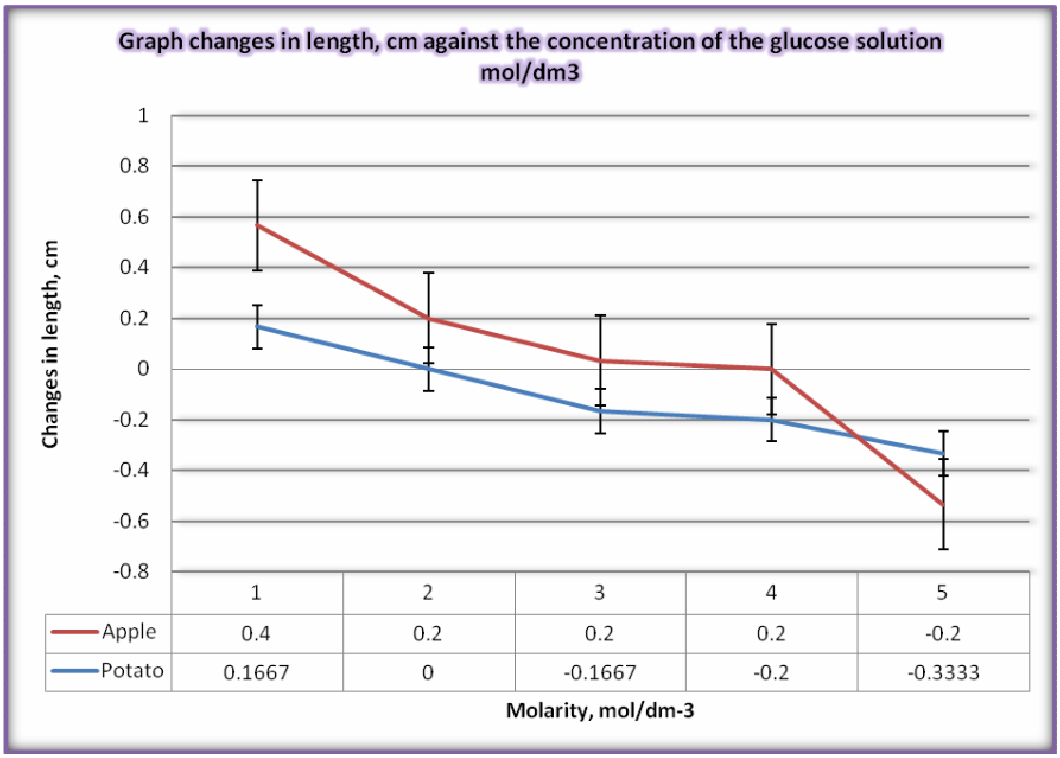

	1	2	3	4	5
Apple	0.4	0.2	0.2	0.2	-0.2
Potato	0.1667	0	-0.1667	-0.2	-0.3333

Graph 1.3: Shows the comparison between the apple and potato line graph.

- **Note that the number in the x-axis represents the following:**

  1 = 0.2 mol
  2 = 0.3 mol
  3 = 0.4 mol
  4 = 0.5 mol
  5 = 1.0 mol

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Qualitative quantity:

Table 4.1: Table shows the observational data of physical condition of each apple strips and level of glucose solution after being immersed in sucrose solution for 240 minutes level of glucose solution

Concentration of glucose solution mol/dm³	0.2	0.3	0.4	0.5	1.0
Physical condition of each apple strips	Very turgid and firm	Very turgid and firm	Flaccid and soft	Flaccid and soft	Flaccid and soft
Level of glucose solution	Increase	Increase	Increase	Increase	Decrease
Length of apple strips	Decrease	Decrease	Decrease	Decrease	Increase

Table 4.2: Table shows the observational data of physical condition of each potato strips and level of glucose solution after being immersed in sucrose solution for 240 minutes level of glucose solution

Concentration of glucose solution mol/dm³	0.2	0.3	0.4	0.5	1.0
Physical condition of each potato strips	Very turgid and firm	No change in turgidity	Turgid and firm	Turgid and firm	Very turgid and firm
Level of glucose solution	Increase	No change	Decrease	Decrease	Decrease
Length of potato strips	No change	No change	Increase	Increase	Increase

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Conclusion:

Based on the apple strips result:
0.2M, 0.3M, 0.4M and 0.5M glucose solutions can be conclude that they are hypotonic to the cell sap of apple strips. This is because the length of the apple strips increases as the strips are immersed in the glucose solutions with those concentrations.

1.0M glucose solution is hypertonic to the cell sap of the apple strips. This is proven when the length of the strips decreases when they are immersed in 1.0M concentration of glucose solution. Based on the graph, it is believed that the concentration of glucose that is isotonic to cell sap of apple strips is approximately 0.75M.

Based on the potato strips result:
The solutions in 0.2M and 0.3M of glucose solutions are hypotonic or less concentrated than the cell sap of the strips of potato. Water diffuses into the cells by osmosis. This causes the potato strips to become turgid and firm.

The solutions in 0.5M and 1.0M of glucose solutions are hypertonic or more concentrated than the cell sap of potato tissues. Water leaves the cell by osmosis. This causes the potato strips of potato to decrease.

1. The movement of substances across the plasma membrane depends on the difference gradient of the concentration between the surrounding solution and the cell sap of potato tissue.

2. If the surrounding solution is hypotonic to the concentration of cell sap, then water enters the potato cells by osmosis.

3. If the surrounding solution is hypertonic to the concentration of cell sap, then water leaves the potato cells by osmosis.

4. If both the surrounding solution and the cell sap of potato tissue have the same concentration which is isotonic to each other, then the rate of water movement in and out of the cell is the same. The cells maintain their normal appearance.

The solutions in 0.2 and 0.3M of glucose solutions are hypotonic or less concentrated than the cell sap of the strips of potato. Water diffuses into the cells by osmosis. This causes the potato strips to become very turgid and firm. The solutions in 0.5 and 1.0M of glucose solutions are hypertonic or more concentrated than the cell sap of potato tissues. Water leaves the cell by osmosis. This causes the potato strips of potato to decrease.

Proven by the data and the graph represent the difference in length of the strips, the strips are actually decreasing as the concentration of the glucose increase.

Thus, the hypothesis stated above is not accepted.

Limitations and ways of improvement:

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1. The volume of all solution in this experiment is measured by using 100cm^3 measuring cylinder which is inappropriate in measuring small volume of solution such as 20ml of 1.0 mol of glucose solution. It is suggested that the 20ml of the difference concentration of the glucose solution measured by 10ml pipette which has smaller uncertainties.

2. The potato and the apple strips were prepared by using different tuber or fruit which is then have difference concentration from one another. This will affect the rate of osmosis. It is suggested that the sample should be taken from the same part of the potato. As example the centre part of the apple fruit or the centre part of the potato tuber only. So that the concentrations of the strip will be the same.

3. Because of the human limitations, the cutting of the tuber or apple strips might not be constant. This next can be avoided by placing a ruler at near the specimen to make sure the probability for the cutting to be slanting reduced.

4. There might be parallax error during the reading of the volume of the water. This can be avoided by making sure that the eye levels are the same with the meniscus of water during the reading.

5. The shape of the boiling tube is round which based on human limitations there might be a little slanting thus affect the reading of the volume taken. This is hardly avoided, but it can be reduced by placing the boiling tube on a flat surface by a straight ruler to make sure that there will be less slanting.

6. The time of the experiment should be lengthening. The more the time might bring to more clear and precise result. The time 240 minutes should be lengthening to 480 minutes.

Appendix:

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The preparation of 0.2, 0.3, 0.4, 0.5 mol/dm^3 of glucose solution from 1.0 mol/dm^3 of glucose solution.

Using the formula:

$$M_1V_1 = M_2V_2$$

M□= Molarity of standard solution

V□= Volume of standard solution

M□= Molarity of desired solution

V□= Volume of desired solution

Example: prepare 20cm³ 0.2mol dm □³ glucose solution.

1.0 mol dm □³ (V□) = 0.2mol dm □³ (20cm³)

$$V□ = \frac{0.2\ mol\ dm^{-3}(20cm^3)}{1.0\ mol\ dm^{-3}}$$

V□ = 4.0cm³20cm³